

CSIRO DIVISION OF FISHERIES AND OCEANOGRAPHY

REPORT ON THE MERCHANT SHIP SURFACE SAMPLING PROGRAMME

Faced with the immense problem of investigating the characteristics of the vast ocean areas surrounding Australia and restricted by very limited ship resources, the CSIRO Division of Fisheries and Oceanography sought, with the assistance of the Australian merchant fleet, to undertake a programme of sampling surface water properties. In 1966 several ships were fitted out to make continuous records of the surface water temperature in the Coral and Tasman Seas, and to take water samples which were later analysed to determine their salinity.

The original area of operations was from the Equator to 45° south latitude (below Tasmania) and eastward from the Australian coast to the 180° longitude meridian. Subsequently at the request of the South Eastern Fisheries Committee the programme was extended in 1970 to vessels operating in areas of interest to the Committee.

Shipping companies, agencies and ships that were contributing to the study as at September 1972 are given in Appendix I; it should be recognised that the programme can be quite fluid, with vessels dropping out as their routes change according to company requirements and new vessels being incorporated when possible. CSIRO is at present preparing for publication a technical report on the programme, which will provide up-to-date information and an assessment of the programme.

Appendix II provides a generalised account of the sampling and of some features which have already shown up from the study.

The temperature and salinity data collected by the ships are distributed in the form of computer listings to interested fishery authorities and others. They are used also to prepare atlases containing monthly charts of the temperature and salinity in surface waters.

The atlases are of great value to biologists, oceanographers, and meteorologists interested in the oceans, because they provide an environmental frame of reference against which fish distribution, water movements, and weather phenomena may be interpreted.

They also make possible for the first time in Australian waters the study of the large-scale seasonal changes of temperature and salinity, and the interpretation of these changes as part of the exchange of energy from the atmosphere to the ocean and from ocean to atmosphere. Some cyclones and other weather phenomena off the east coast of Australia are known to have been re-energized from warm surface waters.

The atlases also provide the basic data from which oceanographers can calculate reliable long-term averages of surface temperature and salinity. These averages in turn make possible the detection of long-term changes in the marine climate of the ocean surface, which could have significant effects on fish resources, the weather, and the overall ecological balance.

The sum of \$11,000 was made available from the Fishing Industry Research Trust Account in 1973/74 for the purchase and installation of an automated continuous salinity-temperature recorder on a selected vessel as a pilot study to test the feasibility of this sampling technique with a view to later similar equipping of other suitable vessels in the programme. Such sampling equipment would be useful in any attempt to extend the programme to waters to the north and west of Australia. The installation of more efficient and continuous

sampling equipment provides the only opportunity to study water temperature fronts which have relevance to the behaviour and migration of certain fishery resources.

Arrangements are being made for the purchase of the equipment from overseas and when received it will be installed in a selected vessel. As a reasonable period of operation will be needed in order to have the equipment operating effectively and to test the sampling technique, it might be some time before detailed reporting can be made to the Fishing Industry Research Committee.

SHIPPING COMPANIES, AGENCIES, AND SHIPS CONTRIBUTING TO  
THE STUDY AS AT SEPTEMBER 1973

- American Trading and Shipping Co.  
Pty Ltd (Columbus Line)  
M.V. *Cap Blanco*  
M.V. *Cap Frio*
- Associated Steamships Pty Ltd  
M.V. *Bogong*  
M.V. *Gerringong*  
M.V. *Kooliga*  
M.V. *Kooringa*
- The Australian National Line  
M.V. *Australian Trader*  
M.V. *Empress of Australia*  
M.V. *North Esk*
- The British Phosphate Commissioners  
M.V. *Triaster*  
M.V. *Tri-Ellis*
- The Broken Hill Proprietary Co. Ltd  
M.V. *Iron Endeavour*
- Burns Philp and Company Limited  
M.V. *Braeside*  
M.V. *Bulolo*  
M.V. *Malaita*  
M.V. *Malecula*  
M.V. *Montoro*  
M.V. *Tulagi*
- The China Navigation Company Ltd  
M.V. *Soochow*
- Colonial Sugar Refining Company Ltd  
M.V. *Rona*
- Department of Shipping and Transport  
M.V. *Cape Moreton*  
M.V. *Cape Pillar*
- Fiji-Australia Line Ltd  
(General Agents: Swire & Gilchrist Pty Ltd)  
M.V. *Taiyuan*
- Holm Shipping Company Limited  
M.V. *Holmburn*
- Karlander (Aust.) Pty Ltd  
M.V. *Safia*  
M.V. *Sarang*  
M.V. *Sletfjord*  
M.V. *Sletholm*  
M.V. *Slidre Timur*
- Messageries Maritime (Cie Des)  
(Agents: France Australia Holdings Pty Ltd)  
M.V. *Polynésie*
- Nauru Pacific Shipping Lines  
M.V. *Enna G*  
M.V. *Rosie D.*
- New Guinea Australia Line Pty Ltd  
(Agents: Swire and Gilchrist Pty Ltd)  
M.V. *Coral Chief*  
M.V. *Island Chief*
- Union Steam Ship Company of New Zealand  
Limited  
M.V. *Kaitoke*  
M.V. *Maheno*  
M.V. *Ngakuta*  
M.V. *Seaway King*  
M.V. *Tofua*  
M.V. *Waikare*  
M.V. *Waimea*
- The Wholesale Society (Gilbert and Ellice  
Islands)  
M.V. *Moana Roai*  
M.V. *Ninikoria*

A thermograph is fitted on nearly all the ships in the programme. This measures the temperature of the sea water used to cool the ship's engines and makes a continuous recording of the temperature on a paper disc. Intake depths vary from 10 to 20 feet below the sea surface. The sea-water samples are drawn from the same intake. When a sample is taken a mark is punched on the thermograph record indicating the time, and the ship's position is entered in a special log kept on the bridge. A few vessels still collect temperatures and water samples by a bucket lowered from the deck, but this method is being phased out.

Thermograph records, log forms, and water samples are collected when the ships are in port, principally in Sydney, but also in Port Kembla, Melbourne, Hobart, Brisbane, and Cairns. Some of the data and samples are transhipped from Fiji and New Zealand to Sydney.

The salinity of the water samples is determined on a Hamon salinometer. This analysis and the computer processing of the data are done at the Division's headquarters laboratory at Cronulla, N.S.W., where the preparation of the monthly charts and their interpretation are also carried out.

Data that contribute to the overall study are made available to the Division on an exchange basis by the Oceanographical Institute of the Department of Scientific and Industrial Research, Wellington, New Zealand; Defence Scientific Laboratory, Auckland, New Zealand; Fisheries Research Division, Marine Department, Wellington, New Zealand; and the Institut Francais d'Océanie, Noumea.

The basic data collected in these studies as well as the atlases and the results of the work will be available to the world oceanographic community through the World Data Centres in Moscow and Washington.

Some hitherto unsuspected water movements have emerged from the study. It was already known that between December and March each year tropical water from the equatorial area north of New Guinea moves in a south-easterly direction towards the Solomon Islands where the stream divides, part going to the east of the islands and part to the west.

The major flow is usually the western one, which continues southward along the Australian coast where it merges with the East Australian Current. The eastern stream moves on past the New Hebrides, to the east of New Caledonia and into the area to the north of New Zealand. This is usually a minor flow. In 1970 a dramatic change took place. The major flow went to the east of the Solomon Islands and deposited much warm, tropical water to the north of New Zealand, while relatively little of this water came down the Australian coast.

The 1971 data show a reversion to what appears to be the more usual pattern, the major flow of equatorial tropical water moving down the east Australian coast, and only small quantities moving in the other stream.

What is the normal pattern, and whether the 1970 pattern was a random aberration, will only become clear when the data for a much longer run of years are accumulated.

Another feature which has emerged from the study concerns a decline in the annual averages of salinities off the New South Wales coast. Each year the surface salinities of this region oscillate about this annual average. In general, however, both the winter higher salinities and the summer lower salinities have decreased in value since 1966. The simplest explanation of this is an accumulation of lower salinity waters throughout the year.

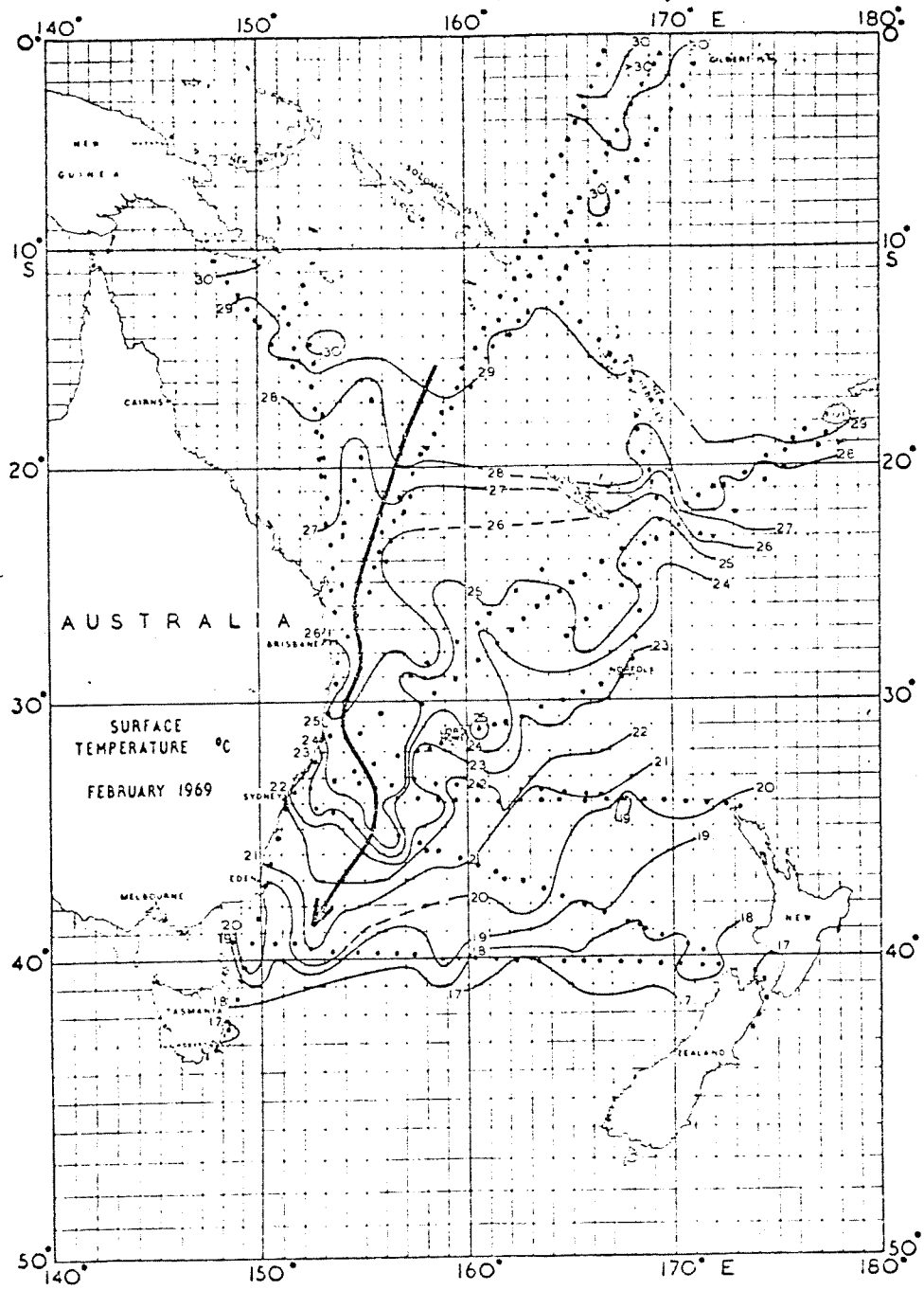
The cause of this accumulation of low-salinity water is traceable back to abnormally low-salinity waters in the vicinity of the New Hebrides in 1967. The low salinities may have been the result of dilution by exceptional rainfall in the area, but the ultimate cause is by no means clear yet.

In the following years there was an anti-clockwise drift of the low-salinity water from the New Hebrides into the western Coral Sea and on down into the Tasman Sea. By 1971 the New Hebrides water had reached the southern coast of New South Wales.

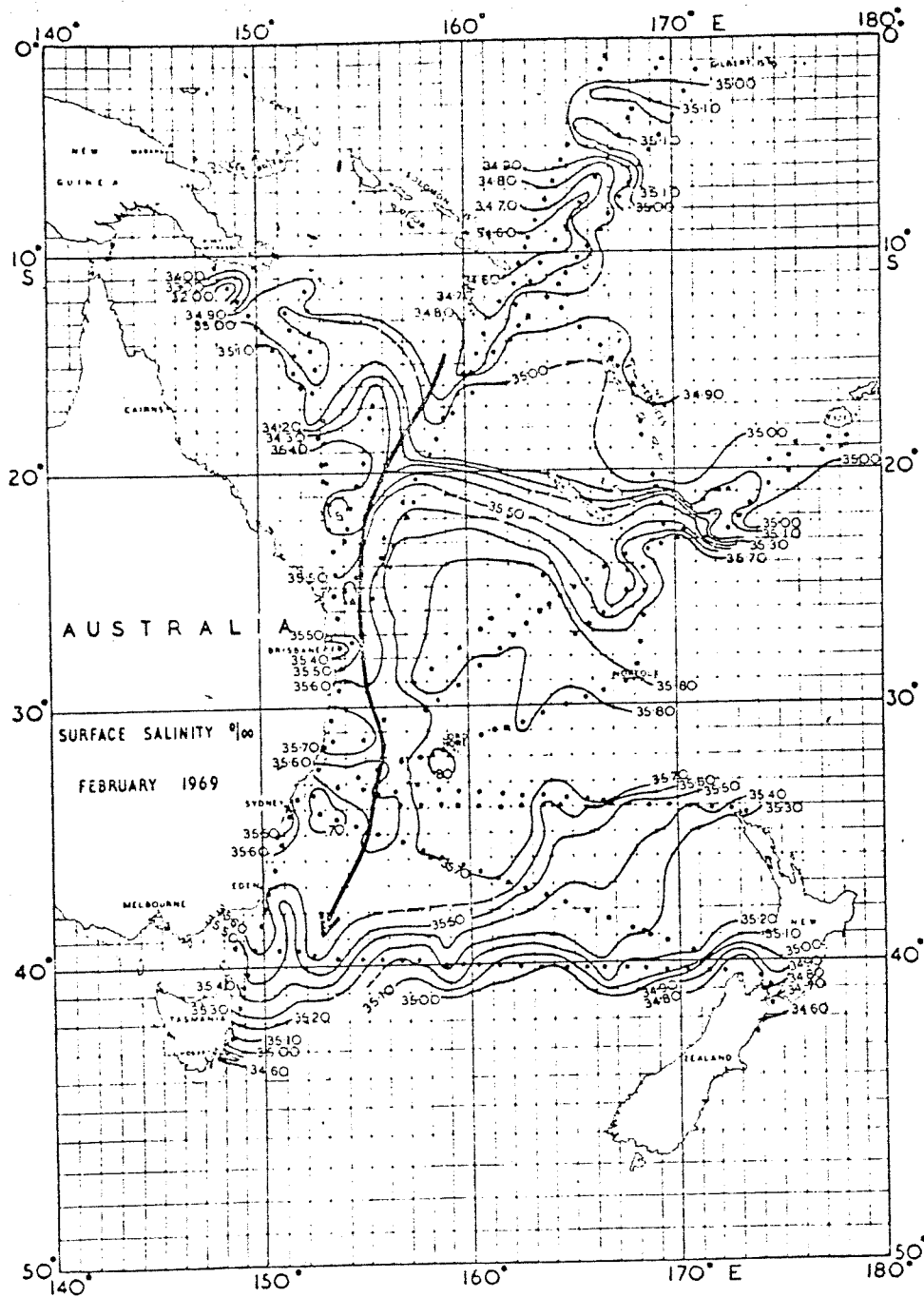
The survey has also revealed a gradual increase in the temperature of the water along the western margin of the Tasman Sea. Again, this is irrespective of the seasonal fluctuations in temperature and applies only to the annual averages which show an increase of at least  $1^{\circ}\text{C}$  since 1966.

The general increase in temperature has been accompanied by an increasing rainfall in eastern New South Wales culminating in the prolonged and heavy rains of 1972.

In the future the use of research vessels, buoys, satellites, etc. can only supplement but never replace the unique large-scale near-synoptic type of sampling that the merchant fleet can supply.



The distribution of surface temperatures in February 1969. The arrowed line shows the axis of warm water tongues extending to the south off eastern Australia.



The distribution of surface salinities in February 1969. The arrowed line shows the axis of lower-salinity water off eastern Australia and so gives an indication of its line of movement. Dots show the positions in which samples were taken.